

PCD File (DRAFT) Format Engineering Units

4.1.3 PCD File Format (HDF Vdata)

4.1.3.1 PCD File Description

This section presents a detailed format of the LPS output PCD file. The LPS generates one each PCD file for the ETM+ Format 1 and Format 2 data during level 0R processing. The PCD items contained in this file are converted to the engineering units (EUs) identified in the Landsat 7 DFCB. The LPS uses the HDF Vdata structure for producing LPS output PCD files. Table 4-7 defines the HDF Vdata structure for the LPS output file containing the PCD data engineering units for the ETM+ Format 1 and Format 2 data.

The LPS output PCD file uses a single/common Vdata structure for reporting each of the major frames received in a PCD cycle. Each PCD major frame is uniquely identified by its associated spacecraft time. This spacecraft time, which is extracted and/or computed from the raw input PCD data, is provided in two different engineering units. The first engineering units present the spacecraft time in the Julian day of year and time format. The second engineering units present the spacecraft time of a PCD major frame time in seconds since January 1, 1993 (**TBR**) with double precision floating point (float64) accuracy. The time-in- seconds engineering units format is supported by the LPS to comply the HDF Vdata type restrictions.

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Table 4-7: PCD File - HDF Vdata Definition and Attributes

Vdata Name: LXsssfYDDOYHHuuv.xxx		where: xxx = PCD (also see Section 3.5 for details on LPS file naming convention).		
Vdata Class: LPS_PCD				
Interlace Type: FULL_INTERLACE				
Bytes Per Logical Record: (TBD)				
Number of Records: One record per PCD major frame (4.096 spacecraft seconds)				
Field Name	Number Type	Order	Description	Remarks
<i>PCD Major Frame Identification Data</i> <i>(not a Vdata Table Attribute/entry)</i>	-	-	<i>A new PCD major frame is inserted in the PCD file every 4.096 seconds of the spacecraft time (or every 40.960 seconds during Level 0R processing at 7.5 Mbps).</i> <i>All PCD data are presented in their respective engineering units (EUs) as noted in the Landsat 7 DFCB.</i>	<i>One full PCD major frame consisting of a maximum of 128 minor frames, each containing 128 8-bit words (total 16,384 bytes) , is included in each PCD record. No PCD bytes, valid or not, are dropped by LPS. See Landsat 7 DFCB for details on PCD words/bytes. A summary of PCD locations by PCD cycle/major frame/word is provided in the appendix A in this DFCB.</i>
cycle_count	uint8	1	PCD cycle number (00-99) There could be approximately 52 PCD cycles in a 14 minute long subinterval.	The PCD Cycle number associated with PCD major frame reported in this record of the PCD file. A PCD cycle consists of 4 consecutive PCD major frames. This number is incremented by 1 for each PCD major frame (0) (identified by spacecraft ID and timecode in words 72 of minor frames 96-102) received in the ETM+ sub-interval.

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majf_count	uint8	1	PCD major frame counter value (001-999) There could be approximately 206 PCD major frames in a 14 minutes subinterval (PCD major frame time = 4.096 seconds).	The major frame counter value of the PCD major frame reported in this record of the subinterval PCD file. The PCD major frame number is incremented by one for each new PCD major frame added to this file.
majf_id	uint8	1	PCD major frame ID (0-3)	The PCD major frame ID is determined by the information contained in word 72, minor frames 96-103 of each PCD major frame contained in a PCD cycle. PCD major frame (0) is identified by the presence of spacecraft ID and timecode information in the word 72 locations. Other PCD major frames are identified by their ID numbers (1-3).
majf_time	float64	1	PCD major frame time in seconds since January 1, 1993 (TBR)	This time is the PCD major frame time (majf_timecode; see next entry) converted by LPS to seconds since January 1, 1993.
majf_timecode	char8	19	PCD major frame time of the form 'YY:ddd:hh:mm:ss.tttttt' where: YY: Last two digits of Julian Year ddd: Day (01 through 366) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) tttttt: milliseconds (0 - 9999999) The unit of the fractional seconds field (tttttt) is 1/10 microsecond.	For PCD major frame (0), the spacecraft time is extracted from PCD Major frame (0) of a PCD cycle. For PCD major frames 1-3, the spacecraft timecode is interpolated using the spacecraft time received for PCD major frame (0) of the associated PCD cycle.
<i>Selected PCD Items</i> <i>(Not a Vdata Table Attribute/Entry)</i>	-	-		

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bands_present	char8	6	Bands present indicator, a 123456 or 678\$\$\$ if all bans are present for format 1 or format 2, respectively. A "-" indicates a missing band (e.g., '123-56' or '6-8\$\$\$'. The \$\$\$ indicate 3 blank spaces.	This information is extracted from the third PCD major frame, minor frame 32, word 72, bits 0 through 6.
fac_flag	uint8	1	Full Aperture Calibration door flag: (0 = no activity, 1 = activity)	ETM+ Calibration Activity Status. This status is interpolated from "serial word P of the third PCD major frame, minor frame 83, word 72, bits 2 and 3.
<i>PCD Major Frame Quality and Accounting Data</i> <i>(Not a Vdata Table Attribute/Entry)</i>	-	-		
majf_bytes	uint32	1	Total major frame PCD bytes received	Possible range: 0 - 147,456 in a PCD major frame
majf_bytes_lost	uint32	1	Total PCD major frame bytes missing majf_bytes_lost = 0 - 147,456 for a PCD major frame	The total number of PCD bytes identified as missing due to missing/erroneous VCDUs.
vcdu_errors	uint32	1	Number of erroneous VCDUs with PCD	Possible range: 0 - 36,864 for a PCD major frame
vote_errors	uint32	1	The total number of unpacked PCD major frame bytes containing voting errors	Possible range = 0 - 16384
minf_sync_errors	uint32	1	Total number of PCD minor frame sync errors within a major frame	Possible range: 0 - 128
minf_count_errors	uint32	1	Total number of PCD minor frames received with incorrect minor frame counter values.	Possible range: 0 - 128

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minf_fill	uint32	1	Total number of filled PCD minor frames. minf_fill = 0 - 128	Total number of PCD minor frames received with erroneous data and filled by LPS with a known value (TBR) .
majf_flag	uint8	1	PCD major frame flag where: 0 = valid major frame ID 1 = incorrect major frame ID; corrected by LPS	Indicates the quality of the PCD major frame ID found in word 72, minor frames 96-103 of PCD major frame (1), (2) and (3).
timecode_flag	uint8	1	Valid PCD timecode flag, where: 0 = valid timecode 1 = computed timecode	Indicates the quality of the spacecraft ID and timecode data contained in word 72 locations of PCD major frame (0).
<i>PCD Major Frame Data</i> <i>(Not a Vdata Table Attribute/Entry)</i>				
spacecraft_id	char8	1	spacecraft_id = "7",	The Landsat 7 spacecraft id is determined from bytes 0-3 of PCD timecode word 96 located in major frame (0) of each PCD cycle. For the remaining three major frames in a PCD cycle, this spacecraft id is copied for each major frame. The spacecraft id is also forced to "7" when an erroneous id is read.
sv_clk_last_u/d_time	float64	1	sv_clk_last_u/d_time = 0 - 31,622,400 seconds from midnight of the first day of the current year. This time is presented as a double precision floating point number in HDF to accommodate the 48 bit extended precision floating point value/sample received in the PCD data.	See L7 DFCB section 3.2.7.4.6 for details on the SV clock last update time. Appendix A in this DFCB lists the minor frame locations of the SV clock last update time in major frame (0) of a PCD cycle. This time may be repeated (copied) for other major frames in the PCD cycle.

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time_drift_bias_c0	int16	1	Spacecraft time drift bias (C0) = 0 to +/-15 milliseconds (TBR):	See L7 DFCB section 3.2.7.4.7 for details on the SV (spacecraft) time drift characterization data. Appendix A in this DFCB lists the minor frame locations in major frame (0) of a PCD cycle.
time_drift_rate_c1	int16	1	Spacecraft clock drift rate (C1) = 0 - +/- TBD milliseconds/day;	See above
time_drift_acceln_c2	int16	1	Spacecraft clock drift acceleration (C2) = 0 - +/- TBD milliseconds/day ²	See above
<i>ETM+ TLM @ 4.096 seconds Rate</i> <i>(Not a Vdata Table Attribute/entry)</i>	-	-	<i>Repeat the following PCD values for each PCD major frame. If a major frame does not contain the required PCD value, fill these with all ones (FFFF in hexadecimal).</i>	<i>The following PCD values should be copied in the same format as found in their respective PCD words/minor frames in a PCD major frame. Appendix A in this DFCB lists the words/minor frame locations in a PCD major frame.</i>
black_body_temp_iso	uint8	1	Black Body Temperature (Isolated)	See above
cfpa_heater_current	uint8	1	CFPA Heater Current	See above
cal_shutr_flag_temp	uint8	1	Calibration Shutter Flag Temperature	See above
b/u_shutr_flag temp	uint8	1	Backup Shutter Flag Temperature	See above
black_body_temp_con	uint8	1	Black Body Temperature (Control)	See above
baffle_temp_heater	uint8	1	Baffle Temperature (Heater)	See above
cfpa_control_temp	uint8	1	CFPA Control Temperature	See above
pdf_a/d_ground_ref	uint8	1	PDF A/D Ground Reference	See above
mux1_elec_temp	uint8	1	Mux 1 Electronics Temperature	See above

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mux1_ps_temp	uint8	1	Mux 1 Power Supply Temperature	See above
mux2_elec_temp	uint8	1	Mux 2 Electronics Temperature	See above
mux2_ps_temp	uint8	1	Mux 2 Power Supply Temperature	See above
serial_word_j	uint8	1	Serial Word "J"	See above
serial_word_k	uint8	1	Serial Word "K"	See above
serial word_l	uint8	1	Serial Word "L"	See above
serial word "n"	uint8	1	Serial Word "N"	See above
serial_word "p"	uint8	1	Serial Word "P"	See above
serial_word_q	uint8	1	Serial Word "Q"	See above
serial_word_s	uint8	1	Serial Word "S"	See above
acs_cpu_mode	uint8	1	ACS CPU Mode	See above
<i>ETM+ TLM @16.384 seconds Rate</i> <i>(Not a Vdata Table Attribute/entry)</i>	-	-	<i>Repeat the following PCD values for each PCD major frame. If a major frame does not contain the required PCD value, fill these with all ones (FFFF in hexadecimal).</i>	<i>The following PCD values should be copied in the same format as found in their respective PCD words/minor frames in a PCD major frame. Appendix A in this DFCB lists the words/minor frame locations in a PCD major frame.</i>
etm_tlm_mnf_16_30	uint8	15	ETM TLM MF(2), mfs(16-30)	See above
serial_word_a	uint8	1	Serial Word "A"	See above
serial_word_b	uint8	1	Serial Word "B"	See above
serial_word_c	uint8	1	Serial Word "C"	See above
serial_word_d	uint8	1	Serial Word "D"	See above
serial_word_e	uint8	1	Serial Word "E"	See above
serial_word_f	uint8	1	Serial Word "F"	See above
serial_word_g	uint8	1	Serial Word "G"	See above

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serial_word_h	uint8	1	Serial Word "H"	See above
serial_word_i	uint8	1	Serial Word "I"	See above
etm_tlm_mnf_40_49	uint8	10	ETM TLM MF(2) mfs(40-49)	See above
etm+_on_time	float64	1	<p>Time ETM+ was last on: etm+_on_time = 0 - 31,622,400 seconds from midnight of the first day of the current year.</p> <p>Reported for each PCD major frame (0) record. If a PCD major frame (1, 2 or 3) does not contain the required PCD value, use all ones (hexadecimal FFFF) as the fill value (TBR)</p>	<p>See L7 DFCB sections 3.2.7.4.6 and 3.2.7.4.16 for details on this time. Appendix A in this DFCB lists the word/minor frame locations of this time data in major frame (0) of a PCD cycle.</p> <p>Reported as an HDF double precision floating point number to accommodate the 48 bit extended precision floating point value/sample received in major frame (0) of a PCD cycle.</p>
etm+_off_time	float64	1	<p>Time ETM+ was last off: See above for related description.</p>	See above
<i>Ephemeris Data</i> <i>(Not a Vdata Table Attribute/entry)</i>		-	<i>The ephemeris data, consisting of the position and velocity components, is available on a PCD major frame basis.</i>	<p>See L7 DFCB section 3.2.7.4.8 for details on the Ephemeris data. Appendix A in this DFCB lists the source minor frame locations for the Ephemeris position and velocity components. Note: The ephemeris data source minor frame locations change for odd and even number major frames (0 - 3).</p>
ephem_position_x	float32	1	Position Range: +/- 8.3886 x 10 ⁶ meters	see above
ephem_position_y	float32	1	see above	see above
ephem_position_z	float32	1	see above	see above
ephem_velocity_x	float32	1	Velocity Range: +/- 8.0 meters/milliseconds	see above
ephem_velocity_y	float32	1	see above	see above
ephem_velocity_z	float32	1	see above	see above

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Attitude Estimate <i>(Not a Vdata Table Attribute/entry)</i>	-	-		See DFCB section 3.2.7.4.5, and Appendix A in this DFCB for word/minor frame locations of the attitude data in PCD major frames or the PCD cycle.
attitude_est_epa1	float32	1	Attitude Euler parameter EPA1	same as above
attitude_est_epa2	float32	1	Attitude Euler parameter EPA2	same as above
attitude_est_epa3	float32	1	Attitude Euler parameter EPA3	same as above
attitude_est_epa4	float32	1	Attitude Euler parameter EPA4	same as above
Gyro (IMU Axes) Data <i>(Not a Vdata Table Attribute/entry)</i>	-	-	<i>Note: The following IMU axes (X,Y,Z) readings are repeated 64 times in each major frame. The IMU axes values are in arc-seconds of angular motion. A total of 256 readings (samples) are collected for each PCD cycle.</i>	<i>See L7 DFCB section 3.2.7.4.3 for details on Gyro data. Appendix A in this DFCB lists the source minor frame locations for the Gyro/IMU X,Y,Z components in a PCD major frame. Each IMU axes counter value is first constructed by concatenating the three bytes for each axis (e.g. X1, X2 and X3) and then converted to arc-seconds. For converting the IMU counter values to engineering units, each increment or decrement in the 24-bit counter value of an IMU axes represent a 0.061 arc-second change.</i>
imu_x_roll_nn	float32	1	where imu_x_roll_nn = - 511705.088 to + 511705.027 arc-seconds, and; nn = 0-63 represents the sample number within the major frame.	see above
imu_y_pitch_nn	float32	1	see above	see above
imu_z_yaw_nn	float32	1	see above	see above

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<i>Gyro Drift Data</i> <i>(Not a Vdata Table entry)</i>		-	<i>Note: The Gyro drift data is reported once per PCD cycle in major frame (0) only.</i>	<i>See L7 DFCB section 3.2.7.4.4 for details on the Gyro Drift data. Appendix A in this DFCB identifies the source minor frame locations for Gyro Drift data.</i>
theta-bx	float64	1	The units of gyro drift (rate) data for each axis are in radians/512 milliseconds.	The least significant bit weight of the theta value is adjusted to 2^{-47} before converting to engineering units.
theta-by	float64	1	see above	see above
theta-bz	float64	1	see above	see above
<i>Angular Displacement Sensor Data (ADS)</i> <i>(Not a Vdata Table Attribute/entry)</i>	-	-	<i>Note: The following fields are repeated for each minor frame in the PCD major frame. The minor frame ID (mnfm_mmm) is reported once for a total of 16 sets of ADS X,Y,Z values. The 16 sets of ADS X,Y,Z values are reported for each of the 128 minor frames in a PCD major frame.</i> <i>All ADS X,Y,Z measurements are converted to microradians and reported in ascending order of their source words and minor frames in a PCD major frame. All data is reported with single floating point precision.</i>	<i>See L7 DFCB section 3.2.7.4.1 for details on ADS data. Appendix A of this DFCB identifies the source minor frame locations of the ADS data components in a PCD major frame. A total of 16 ADS measurements, each consisting of the X,Y and Z components, are received in a PCD minor frame.</i>
mnfm_mmm	uint8	1	Minor frame number or ID where mmm: = 0-127 within each major frame.	The PCD minor frame counter value is found in word location 65 of each minor frame and reported here.

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ads_xnn_mnfm_mmm	float32	1	ADS measurement Xnn received in minor frame mmm, where: mmm = 0-127 (minor frame ID) and nn = 0-15 for ADS component number within a minor frame	see above
ads_ynn_mnfm_mmm	float32	1	ADS measurement Ynn received in minor frame mmm, where: mmm = 0-127 (minor frame ID) and nn = 0-15 for ADS component number within a minor frame	see above
ads_znn_mnfm_mmm	float32	1	ADS measurement Znn received in minor frame mmm, where: mmm = 0-127 (minor frame ID) and nn = 0-15 for ADS component number within a minor frame	see above
ADS Temperatures <i>(Not a Vdata Table Attribute/entry)</i>	-	-	Note - The ADS X,Y,Z and A/D electronic temperature values are reported on a major frame basis. All temperatures are reported in degrees Centigrade (°C).	See DFCB section 3.2.7.4.2 for details. See Appendix A for locating the ADS Temperature data in a PCD major frame.
ads-x_temp_1	float32	1	see above	see above
ads-y_temp_2	float32	1	see above	see above
ads-z_temp_3	float32	1	see above	see above
ads-elec_a/d_temp_4	float32	1	see above	see above
PCD Quality and Accounting Data <i>(Not a Vdata Table Attribute/entry)</i>			The following PCD quality data is produced by LPS and appended to each major frame record of the PCD file.	

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s/c_id_err_pcd	char8	1	Spacecraft ID error in PCD: s/c_id_err_pcd = "n" for no errors "y" for errors detected in the spacecraft ID field	The error flag is true whenever the spacecraft ID is not equal to "7"
att_data_quality	char8	1	Attitude Data Point Quality: att_data_quality = "g" for a good data "r" for rejected data "m" for missing data	Determined and produced by LPS
ephem_data_quality	char8	1	Ephemeris Data Point Quality: ephem_data_quality = "g" for a good data "r" for rejected data "m" for missing data	Determined and produced by LPS

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Appendix C: ADS PCD - Expanded Format (Example)

	-	-		
mnfm_mmm	uint8	1	Minor frame counter or ID where mmm: 0-127 within each major frame.	The PCD minor frame counter value is found in word location 65 of each minor frame and reported here.
ADS_Xnn_mnfm_mmmm	float32	1	ADS measurement X01 received in minor frame 0	
ADS_Ynn_mnfm_mmm	float32	1	ADS measurement Y01 received in minor frame 0	
ADS_Z01_mnfm_mmm	float32	1	ADS measurement Z01 received in minor frame 0	
ADS_X02_mnfm000	float32	1	ADS measurement X02 received in minor frame 0	
ADS_Y02_mnfm000	float32	1	ADS measurement Y02 received in minor frame 0	
ADS_Z02_mnfm000	float32	1	ADS measurement Z02 received in minor frame 0	
/				
/			A total of 16 sets of ADS X,Y, Z components are reported for each minor frame.	
/				
ADS_X16_mnfm000	float32	1	ADS measurement X02 received in minor frame 001	
ADS_Y16_mnfm000	float32	1	ADS measurement Y02 received in minor frame 001	
ADS_Z16_mnfm000	float32	1	ADS measurement Z02 received in minor frame 001	
Minor Frame ID 001	uint8	1	Minor frame count: 0 - 127 within each major frame	
ADS_X01_mnfm001	float32	1	ADS measurement X01 received in minor frame 001	
ADS_Y01_mnfm001	float32	1	ADS measurement Y01 received in minor frame 001	
ADS_Z01_mnfm001	float32	1	ADS measurement Z01 received in minor frame 001	
ADS_X02_mnfm001	float32	1	ADS measurement X02 received in minor frame 001	
ADS_Y02_mnfm001	float32	1	ADS measurement Y02 received in minor frame 001	
ADS_Z02_mnfm001	float32	1	ADS measurement Z02 received in minor frame 001	
/				
/			A total of 16 sets of ADS X,Y, Z components are repotred for each minor frame.	
/				

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ADS_X16_mnfm001	float32	1	ADS measurement X02 received in minor frame 001	
ADS_Y16_mnfm001	float32	1	ADS measurement Y02 received in minor frame 001	
ADS_Z16_mnfm001	float32	1	ADS measurement Z02 received in minor frame 001	
/				
/			All 16 sets of ADS X,Y,Z components are reported for each of 128 minor frames in a PCD major frames.	
/				
Minor Frame ID 127	uint8	1	Minor frame count: 0 - 127 within each major frame	
ADS_X01_mnfm127	float32	1	ADS measurement X01 received in minor frame 127	
ADS_Y01_mnfm127	float32	1	ADS measurement Y01 received in minor frame 127	
ADS_Z01_mnfm127	float32	1	ADS measurement Z01 received in minor frame 127	
ADS_X02_mnfm127	float32	1	ADS measurement X02 received in minor frame 127	
ADS_Y02_mnfm127	float32	1	ADS measurement Y02 received in minor frame 127	
ADS_Z02_mnfm127	float32	1	ADS measurement Z02 received in minor frame 127	
/				
/			A total of 16 sets of ADS X,Y, Z components are reported for each minor frame.	
/				
ADS_X16_mnfm127	float32	1	ADS measurement X02 received in minor frame 127	
ADS_Y16_mnfm127	float32	1	ADS measurement Y02 received in minor frame 127	
ADS_Z16_mnfm127	float32	1	ADS measurement Z02 received in minor frame 127	